Bioreduction of Solid Rocket Motors for Planetary Protection

Sadie Boyle and Yo-Ann Velez, NASA Marshall Space Flight Center
Morgan Sisk, Auburn University

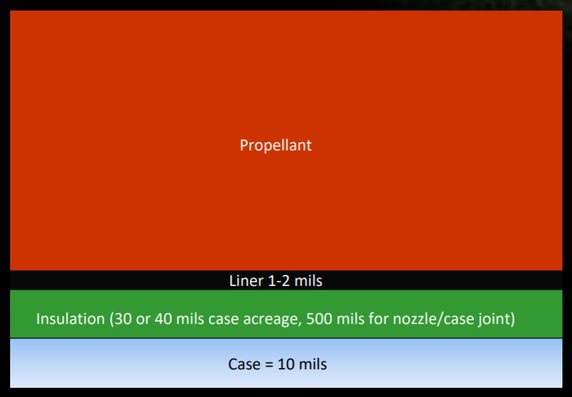
https://ntrs.nasa.gov/search.jsp?R=20190027379 2019-09-26T19:09:30+00:00Z

Abstract

Solid rocket propulsion systems have been used for in-space applications including planetary exploration missions for many years. Current NASA science lander projects require solid rocket propulsion systems to touchdown on the surface of potentially life-supporting planets and moons. A critical requirement of these missions is the prevention of accidental transportation of Earth's microbes to these environments. This mission requirement places an increased importance on the ability to reduce the biological burden that may be on board the solid propulsion systems and potentially deposited in a habitable environment. Some traditional interplanetary spacecraft decontamination operations could reduce the reliability of the solid propulsion system, indicating a need for new decontamination procedures. New techniques for biological burden reduction are being studied and may become the method of choice to ensure adequate reduction has been achieved. These techniques include using innate antimicrobial capacity of chemical agents already present within the motor and cellular disruption due to assembly and operational environments induced in the mated case. Recent investigations into the effectiveness of some of these techniques have generated promising experimental results.

Introduction

- Category IV missions include satellites or landers that might come in contact with a celestial body with chemical evolution or origin-of-life interest.
- Multiple projects of this nature may face difficulties while developing planetary protection procedures for propulsion systems due to the high importance of sustaining material performance assurance for long durations of time, while touching-down on target celestial bodies.
- Solid propellant is a viscoelastic material, meaning when it is stressed or damaged from a process like dry heat microbial reduction (DHMR) some of the material properties are permanently degraded unlike elastic materials.
- This suggests a trade-off between reaching significant levels of bioreduction and, for some of the solid rocket motor components, material reduction of performance.

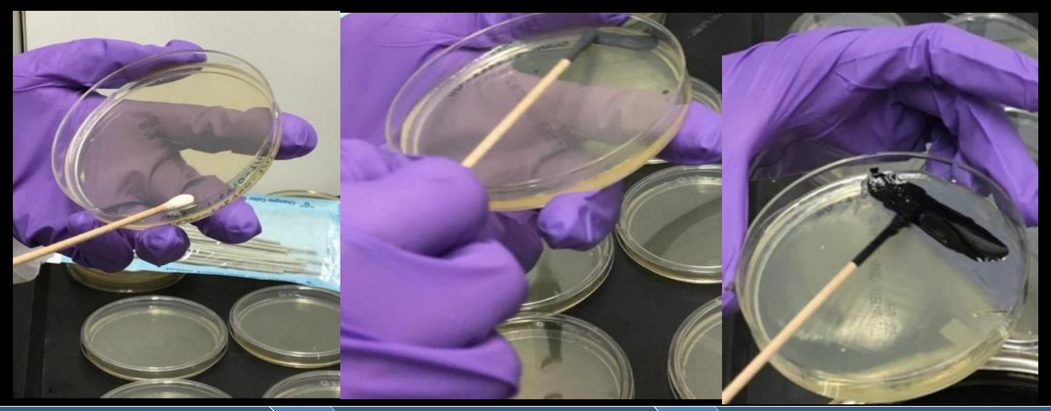


Inner-case components of a solid rocket motor.

Electron microscope image of one of multiple native bacilli found in the solid rocket motor propellant laboratory at the NASA Marshall Space Flight Center, AL.

Methodology

- Chemlok Primer and Adhesive: modified overlay assay (adapted in accordance with adhesive application protocols) with an inoculum derived from a bulk propellant sample.
- Four common aerospace grease types were tested using the Kirby Bauer method against isolated native bacilli.



Application of Inoculum → Application of Primer → Application of Adhesive

Results

- Observable zone of inhibition of vegetative growth indicated active biocidal or biostatic mechanisms in the Chemlok primer and adhesives.
- No antimicrobial properties observed in any of the studied greases.

Material Type	Chemlok 234X	Chemlok 6250	Chemlok 6450	Chemlok 2332
Zone of Inhibition (mm)	67.0	48.0	90.0	46.0

Material Type	Royco® 43	Krytox PFPE	Braycote 803RP	Molykote G-n
Zone of Inhibition (mm)	0	0	0	0

Future Work

Arising from these results other similar experiments are being pursued at Auburn University to study adhesives, insulation, and other components in solid rocket motor manufacturing that might aid in microbial reduction and a lowering of probability of contamination by understanding the inherent antimicrobial capability of solid rocket motor components.

Acknowledgments

The authors would like to thank the Europa Lander De-Orbit stage team at the NASA Marshall Space Flight Center, Dr. Mark Liles at Auburn University, and the Universities Space Research Association (USRA)

References:
[1] Office of Planetary Protection, About Planetary Protection, National Aeronautics and Space Administration, [Online]. Available: https://planetaryprotection.nasa.gov/about. [Accessed 3 August 2018].
[2] G. P. Sutton, Rocket Propulsion Elements, Vol. 7, New York, Wiley, 2010, p. 474.
[3] NASA standard procedures for the microbial examination of space hardware, NASA Procedures and Guidelines (NPG) 6022B, 2010, NASA Headquarters, Washington, DC.